

I CLAIM:

1 1. A system for controlling a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the system comprising:

4 (A) a data gathering system to monitor a surface
5 operating characteristic of the pumping system;

6 (B) a processor in communication with the data
7 gathering system, wherein the processor comprises
8 software that when executed utilizes the operating
9 characteristic to determine the surface card, determines
10 the downhole card, and generates a graphics signal
11 representative of at least one of the surface card ^{and} or the
12 downhole card, and wherein the processor further
13 comprises software for generating a pump control signal;
14 and

15 (C) an output system in communication with the
16 processor, which upon receipt of the graphics signal from
17 the processor provides a viewable graphical
18 representation of the graphics signal.

1 2. The system of claim 1, wherein the pump control
2 signal is provided directly or indirectly to the pump, or
3 provided to a human operator for further processing.

1 3. The system of claim 1, wherein the graphics signal
2 generated by the processor is representative of both the
3 surface card and the downhole card.

1 4. The system of claim 3, wherein the viewable
2 graphical representation of the graphics signal comprises
3 an axis on the surface card representing position having
4 the same scale as an axis on the downhole card
5 representing position.

1 5. The system for monitoring of claim 4, wherein (in
2 near real time) comprises within 12 hours.

1 6. The system for monitoring of claim 4, wherein in
2 near real time comprises within 2 reciprocations of the
3 pump.

1 7. A method of monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the method comprising:

4 (A) monitoring an operating characteristic of the
5 well at the surface;

6 (B) generating at least one of the surface card ^{and} or
7 the downhole card utilizing the operating characteristic;

8 (C) generating a pump control signal based on at
9 least one of the surface card, downhole card ^{and} or operating
10 characteristic; and

11 (D) providing a viewable graphical representation
12 of the surface card or downhole card.

1 8. The method of claim 7, wherein steps (C) and (D)
2 occur in near real time, relative to step (A) of
3 monitoring an operating characteristic.

1 9. The method of claim 8, wherein in near real time
2 comprises within 24 hours.

1 10. The method of claim 8, wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 11. The method of claim 8, wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 12. The method of claim 7, further comprising:
2 (E) providing the control signal directly or
3 indirectly to the pump.

1 13. The method of claim 7, in which step (C) first
2 comprises comparing the surface or downhole card to ideal
3 cards.

1 14. The method of claim 13, further comprising:
2 (F) repeatedly repeating steps (A), (B), (C), (D),
3 and (E).

1 15. A system for monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the system comprising a
4 computer receiving data regarding an operating
5 characteristic of the pump, and comprising software that
6 when executed instruct the system to:

7 (A) monitor an operating characteristic of the well
8 at the surface;

9 (B) generate at least one of the surface card or
10 the downhole card utilizing the operating characteristic;

11 (C) generate a pump control signal based on at
12 least one of the surface card, downhole card and or operating
13 characteristic; and

14 (D) provide a viewable graphical representation of
15 the surface card or downhole card.

1 16. The system of claim 15, wherein instructions (C) and
2 (D) occur in near real time, relative to instruction (A)
3 of monitoring an operating characteristic.

1 17. The system of claim 16, wherein in near real time
2 comprises within 24 hours.

1 18. The system of claim 16, wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 19. The system of claim 16, wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 20. The system of claim 15, further comprising software
2 that when executed instructs the system to:

3 (E) provide the control signal directly or
4 indirectly to the pump.

1 21. The system of claim 15, in which instruction (C)
2 first comprises comparing the surface or downhole card to
3 ideal cards.

1 22. The system of claim 21, further comprising software
2 that when executed instructs the system to:

3 (F) repeatedly repeat steps (A), (B), (C), (D), and
4 (E).

1 23. A computer-readable storage medium having stored
2 thereon a plurality of instructions for controlling a
3 reciprocating pump producing hydrocarbons from a wellbore
4 extending from the surface into the subterranean, said
5 instructions that when executed by a computer instruct
6 the computer to:

7 (A) monitor an operating characteristic of the well
8 at the surface;

9 (B) generate at least one of the surface card or
10 the downhole card utilizing the operating characteristic;

11 (C) generate a pump control signal based on at
12 least one of the surface card, downhole card or operating
13 characteristic; and

14 (D) provide a viewable graphical representation of
15 the surface card or downhole card.

1 24. The medium of claim 23, wherein instructions (C) and
2 (D) occur in near real time, relative to instruction (A)
3 of monitoring an operating characteristic.

1 25. The medium of claim 24, wherein in near real time
2 comprises within 24 hours.

1 26. The medium of claim 24, wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 27. The medium of claim 24, wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 28. The medium of claim 23, further comprising software
2 that when executed instructs the system to:

3 (E) provide the control signal directly or
4 indirectly to the pump.

FOOTNOTES

1 29. The medium of claim 23, in which instruction (C)
2 first comprises comparing the surface or downhole card to
3 ideal cards.

1 30. The medium of claim 29, further comprising software
2 that when executed instructs the system to:

3 (F) repeatedly repeat steps (A), (B), (C), (D), and
4 (E).

1 31. A propagated signal comprising a plurality of
2 instructions for controlling a reciprocating pump
3 producing hydrocarbons from a wellbore extending from the
4 surface into the subterranean, said instructions that
5 when executed by a computer instruct the computer to:

6 (A) monitor an operating characteristic of the well
7 at the surface;

8 (B) generate at least one of the surface card or
9 the downhole card utilizing the operating characteristic;

1 36. The signal of claim 31, further comprising software
2 that when executed instructs the system to:

3 (E) provide the control signal directly or
4 indirectly to the pump.

1 37. The signal of claim 31, in which instruction (C)
2 first comprises comparing the surface or downhole card to
3 ideal cards.

1 38. The signal of claim 37, further comprising software
2 that when executed instructs the system to:

3 (F) repeatedly repeat steps (A), (B), (C), (D), and
4 (E).

5 39. A system for monitoring a reciprocating pump
6 producing hydrocarbons from a wellbore extending from the
7 surface into the subterranean, the system comprising:

8 (A) a data gathering system to monitor a surface
9 operating characteristic of the pumping system;

10 (B) a processor in communication with the data
11 gathering system, wherein the processor comprises
12 software that when executed utilizes the operating
13 characteristic to determine the surface card, determines
14 the downhole card, and generates a graphics signal
15 representative of the surface card or the downhole card;
16 and

17 (C) an output system in communication with the
18 processor, which upon receipt of the graphics signal from
19 the processor provides a viewable graphical
20 representation of the graphics signal.

1 40. A method of monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the method comprising:

4 (A) monitoring an operating characteristic of the
5 well at the surface;

6 (B) generating a surface card utilizing the
7 operating characteristic;

8 (C) generating a downhole card;

9 (D) generating a viewable graphical representation
10 of both the surface card and the downhole card, wherein
11 for the viewable graphical representation an axis on the
12 surface card representing position is at the same scale
13 as an axis on the downhole card representing position.

10200T" T4002660

1 ✓ 41. The method of claim ⁴⁰(5), wherein step (D) of
2 generating a viewable graphical representation occurs in
3 near real time, relative to step (A) of monitoring an
4 operating characteristic.

1 42. The method of claim ⁴⁰(6), wherein in near real time
2 comprises within 24 hours.

1 43. The method of claim ⁴¹(6), wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 44. The method of claim ⁴¹(6), wherein in near real time
2 comprises within 1 reciprocation of the pump.

112

0970041 100001

45

45

[illegible]

1 48. A system for monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the system comprising a
4 computer receiving data regarding an operating
5 characteristic of the pump, and comprising software that
6 when executed instruct the system to:

7 (A) generate a surface card utilizing the operating
8 characteristic;

9 (B) generate a downhole card; and

10 (C) generate a viewable graphical representation of
11 both the surface card and the downhole card, wherein for
12 the viewable graphical representation an axis on the
13 surface card representing position is at the same scale
14 as an axis on the downhole card representing position.

1 49. The system of claim 13, wherein instruction (C) of
2 generate a viewable graphical representation occurs in
3 near real time.

1 50. The system of claim 14, wherein in near real time
2 comprises within 4 hours.

1 51. The system of claim 14, wherein in near real time
2 comprises within 2 reciprocations of the pump.

1 52. The system of claim ⁴⁹14, wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 53. The system of claim ⁴⁸13, further comprising software
2 that when executed instructs the system to:

3 (D) generate a signal to adjust the operation of
4 the pump if warranted based on the surface card and the
5 downhole card.

1 54. The system of claim ⁵⁷18, in which instruction (D)
2 first comprises instructing the system to compare the
3 downhole card to ideal downhole cards.

1 55. The system of claim ⁵³18, further comprising software
2 that when executed instructs the system to:

3 (E) repeatedly repeat in sequence steps
4 (A), (B), (C), and (D).

1 56. A computer-readable storage medium having stored
2 thereon a plurality of instructions for monitoring a

3 reciprocating pump producing hydrocarbons from a wellbore
4 extending from the surface into the subterranean, said
5 instructions that when executed by a computer instruct
6 the computer to:

7 (A) generate a surface card utilizing an operating
8 characteristic of the pump;

9 (B) generate a downhole card; and

10 (C) generate a viewable graphical representation of
11 both the surface card and the downhole card, wherein for
12 the viewable graphical representation an axis on the
13 surface card representing position is at the same scale
14 as an axis on the downhole card representing position.

1 57. The medium of claim 21, wherein instruction (C) of
2 generate a viewable graphical representation occurs in
3 near real time.

1 58. The medium of claim 22, wherein in near real time
2 comprises within 2 reciprocations of the pump.

1 59. The medium of claim ⁵⁶21, further comprising software
2 that when executed instructs the system to:

3 (D) generate a signal to adjust the operation of
4 the pump if warranted based on the surface card and the
5 downhole card.

1 60. The medium of claim ⁵⁹24, in which instruction (D)
2 first comprises instructing the system to compare the
3 downhole card to ideal downhole cards.

1 61. The medium of claim ⁶⁰24, further comprising software
2 that when executed instructs the system to:

3 (D) repeatedly repeat in sequence steps
4 (A), (B), (C), and (D).

1 62. A propagated signal comprising a plurality of
2 instructions for monitoring a reciprocating pump
3 producing hydrocarbons from a wellbore extending from the
4 surface into the subterranean, said instructions that
5 when executed by a computer instruct the computer to:

6 (A) generate a surface card utilizing an operating
7 characteristic of the pump;

8 (B) generate a downhole card; and

9 (C) generate a viewable graphical representation of
10 both the surface card and the downhole card, wherein for
11 the viewable graphical representation an axis on the
12 surface card representing position is at the same scale
13 as an axis on the downhole card representing position.

1 63. The signal of claim ⁶²27 wherein instruction (C) of
2 generate a viewable graphical representation occurs in
3 near real time.

1 64. The signal of claim ⁶³28, wherein in near real time
2 comprises within 2 reciprocations of the pump.

1 65. The signal of claim ⁶⁴27, further comprising software
2 that when executed instructs the system to:

3 (D) generate a signal to adjust the operation of
4 the pump if warranted based on the surface card and the
5 downhole card.

1 66. The signal of claim ⁶⁵~~30~~, in which instruction (D)
2 first comprises instructing the system to compare the
3 downhole card to ideal downhole cards.

1 67. The signal of claim ⁶⁵~~30~~, further comprising software
2 that when executed instructs the system to:

3 (D) repeatedly repeat in sequence steps
4 (A), (B), (C), and (D).

1 68. A system for controlling a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the system comprising:

4 (A) a data gathering system to monitor a surface
5 operating characteristic of the pumping system;

6 (B) a database of ideal cards;

7 (C) a processor in communication with the data
8 gathering system and the database, wherein the processor
9 comprises software that when executed utilizes the
10 operating characteristic to determine at least one of the
11 surface card or downhole card, and wherein the processor
12 further comprises software that when executed makes a
13 comparison of the determined card against the database
14 and generates a control signal dependent upon the
15 comparison.

1 69. The system of claim 68, wherein the control signal
2 is provided to ~~and~~ alters the operation of the pump.

1 70. The system of claim 69 wherein the processor
2 generates the control signal in near real time.

1 71. The system for of claim 70, wherein in near real
2 time comprises within 12 hours.

1 72. The system of claim 70, wherein in near real time
2 comprises within 2 reciprocations of the pump.

1 73. A method of monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the method comprising:

4 (A) monitoring an operating characteristic of the
5 well at the surface;

6 (B) generating a surface card utilizing the
7 operating characteristic;

8 (C) generating a downhole card;

9 (D) comparing the downhole card to a database of
10 ideal downhole cards, and generating a comparison signal
11 based on the comparing.

1 74. The method of claim 38, wherein step (D) of
2 comparing occurs in near real time, relative to step (A)
3 of monitoring an operating characteristic.

[illegible]

24

74
39, w

13

74

EXPRESS MAIL NO EL 872 048 336 US

29

1 80. The method of claim 44, further comprising:

2 (F) repeatedly repeating in sequence steps (A),
3 (B), (C), (D), and (E).

1 81. A system for monitoring a reciprocating pump
2 producing hydrocarbons from a wellbore extending from the
3 surface into the subterranean, the system comprising a
4 computer receiving data regarding an operating
5 characteristic of the pump, and comprising software that
6 when executed instruct the system to:

7 (A) generate a surface card utilizing the operating
8 characteristic;

9 (B) generate a downhole card;

10 (C) compare the downhole card to a database of
11 ideal downhole cards, and generating a comparison signal
12 based on the comparing.

81

1 82. The system of claim 46, wherein instruction (C) of
2 compare occurs in near real time.

FOOTNOTES

1 83. The system of claim ~~47~~⁸², wherein in near real time
2 comprises within 24 hours.

1 84. The system of claim ~~47~~⁸², wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 85. The system of claim ~~47~~⁸², wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 86. The system of claim ~~47~~⁸², wherein the comparison
2 signal is provided to ~~and~~ alters the operation of the
3 pump.

1 87. The system of claim ~~47~~⁸², further comprising:
2 (D) generate a viewable graphical representation of
3 both the surface card and the downhole card, wherein for
4 the viewable graphical representation an axis on the
5 surface card representing position is at the same scale
6 as an axis on the downhole card representing position.

1 88. The system of claim 52, further comprising:

2 (F) repeatedly repeating in sequence instructions
3 (A), (B), (C), (D), and (E).

1 89. A computer-readable storage medium having stored
2 thereon a plurality of instructions for monitoring a
3 reciprocating pump producing hydrocarbons from a wellbore
4 extending from the surface into the subterranean, said
5 instructions that when executed by a computer instruct
6 the computer to:

7 (A) generate a surface card utilizing the operating
8 characteristic;

9 (B) generate a downhole card;

10 (C) compare the downhole card to a database of
11 ideal downhole cards, and generating a comparison signal
12 based on the comparing.

1 90. The medium of claim 54, wherein instruction (C) of
2 compare occurs in near real time.

90

1 91. The medium of claim 55, wherein in near real time
2 comprises within 24 hours.

90

1 92. The medium of claim 55, wherein in near real time
2 comprises within 10 reciprocations of the pump.

90

1 93. The medium of claim 55, wherein in near real time
2 comprises within 1 reciprocation of the pump.

90

1 94. The medium of claim 55, wherein the comparison
2 signal is provided to and alters the operation of the
3 pump.

90

1 95. The medium of claim 55, further comprising:

2 (D) generate a viewable graphical representation of
3 both the surface card and the downhole card, wherein for
4 the viewable graphical representation an axis on the
5 surface card representing position is at the same scale
6 as an axis on the downhole card representing position.

09070041-100201

76 - 95 96?

1 96. The medium of claim 60, further comprising:
2 (F) repeatedly repeating in sequence instructions
3 (A), (B), (C), (D), and (E).

1 97. A propagated signal comprising a plurality of
2 instructions for monitoring a reciprocating pump
3 producing hydrocarbons from a wellbore extending from the
4 surface into the subterranean, said instructions that
5 when executed by a computer instruct the computer to:

6 (A) generate a surface card utilizing the operating
7 characteristic;

8 (B) generate a downhole card;

9 (C) compare the downhole card to a database of
10 ideal downhole cards, and generating a comparison signal
11 based on the comparing.

1 98. The signal of claim 62, wherein instruction (C) of
2 compare occurs in near real time.

1 99. The signal of claim ~~63~~⁹⁸, wherein in near real time
2 comprises within 24 hours.

1 100. The signal of claim ~~63~~⁹⁹, wherein in near real time
2 comprises within 10 reciprocations of the pump.

1 101. The signal of claim ~~63~~⁹⁸, wherein in near real time
2 comprises within 1 reciprocation of the pump.

1 102. The signal of claim ~~63~~⁹⁸, wherein the comparison
2 signal is provided to ~~and~~ alters the operation of the
3 pump.

1 103. The signal of claim ~~63~~⁹⁸, further comprising:
2 (D) generate a viewable graphical representation of
3 both the surface card and the downhole card, wherein for
4 the viewable graphical representation an axis on the
5 surface card representing position is at the same scale
6 as an axis on the downhole card representing position.

- 1 104. The signal of claim ~~68~~, further comprising:
- 2 9 (F) repeatedly repeating in sequence instructions
- 3 (A), (B), (C), (D), and ~~(E)~~.

109970041-100201